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THE PRODUCTION OF BINDER-TWINE FIBER IN THE PHILIPPINE ISLANDS.

By H. T. EDWARDS, *Specialist in Fiber-Plant Production, Office of Fiber-Plant Investigations.*

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SAFEGUARDING THE SUPPLY OF IMPORTED RAW MATERIALS.

IT IS ONLY within the last five years that any marked degree of attention has been given to the subject of safeguarding the supply of raw products imported into the United States. Apparently it has been assumed that the world production of such important staples as fiber, oil, and rubber would keep pace with the world demand, that there would be a free and relatively unrestricted exchange of these staples, and that there existed no danger of either an immediate or a future shortage of any of these materials.

There has existed, furthermore, a very limited and inadequate understanding of the complex situation that has arisen with the rapid development of modern manufacturing industries. There has been no general comprehension of the fact that there exists to-day a degree of interdependence between different and often widely separated industries that was almost unknown 50 years ago.

The World War brought an awakening with respect to these matters. With a decreased production of certain staple products, with

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an increased demand for these same products, and with world transportation disorganized, it was made apparent that conditions might easily arise at any time which would seriously cripple a number of the basic and essential American industries. It was shown that the farmer is now dependent on the manufacturer and that the manufacturer is equally dependent in many instances on supplies of raw material imported from foreign countries over which the United States has absolutely no control. It was demonstrated beyond question that action should be taken in this country, wherever such action may be possible, to safeguard our future supply of the raw materials that are essential to the normal operation of our leading agricultural and manufacturing industries.

THE BINDER-TWINE FIBER SITUATION.

An illustration of the weakness of our industrial situation with respect to imported raw products is furnished by the conditions existing in the binder-twine industry.

With an annual production of approximately 2½ billions of bushels of grain crops that are largely harvested by machinery, the American farmers require each year about 200 million pounds of binder twine. Without this twine the machines can not be operated, the crops harvested, and the food supply of the country maintained.

With the exception of very limited quantities, the entire supply of binder twine used in the United States is manufactured from henequen and sisal fibers, and more than 90 per cent of the total supply of these fibers imported into the United States is received from Mexico. Henequen production in Mexico is confined largely to the one relatively small State of Yucatan (fig. 1). It is apparent, therefore, that any condition in Yucatan that might result in a material decrease in the output of henequen or any condition of world affairs that might result in the supply of Yucatan fiber being diverted to markets other than those of the United States would seriously affect the production of the most important staple food crops of this country.

The locations of political disturbances and of military operations during the last six years have not been such as largely to reduce the production or seriously to interfere with the distribution of Yucatan henequen. American manufacturers have been able to obtain the required supply of this fiber, although at prices representing an increase of approximately $28,000,000 in the yearly binder-twine bill of the American farmer. There is no assurance, however, that disturbances of the future or that increasing industrial competition under peace conditions may not affect both the production and the distribution of this essential product.

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In order that the farmers of the United States may have reasonable assurance of being able to obtain at all times and under all conditions an adequate supply of binder twine at reasonable prices, it is necessary that an increased supply of binder-twine fiber be produced in United States territory or in countries over which the United States exercises political control. In view of this situation, investigations have been made by the United States Department of Agriculture for the purpose of determining in what places the natural conditions are most favorable for the production of sisal and henequen. As a result of these investigations, cooperative work has

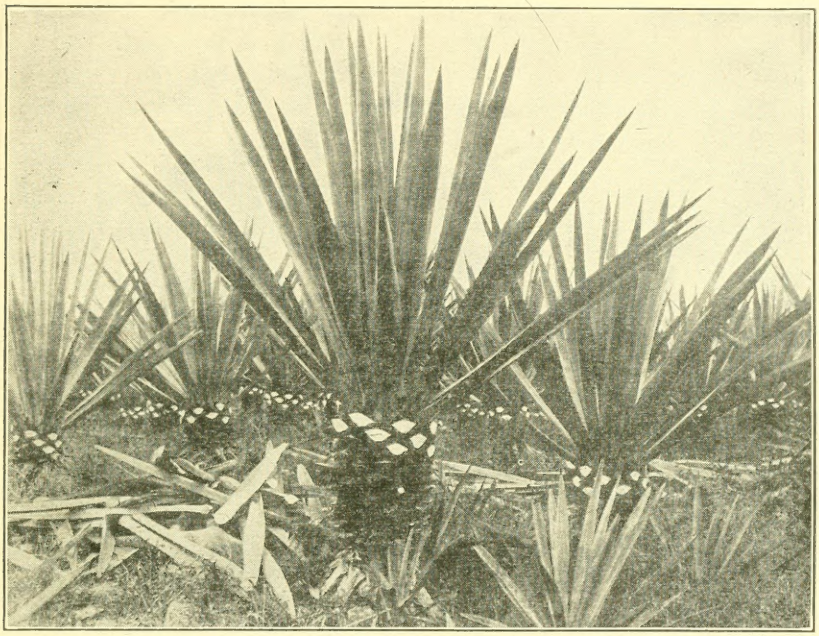

FIG. 1.—Well-developed 9-year-old plants of henequen in Yucatan from which the sixth semiannual crop is being harvested.

been carried on during the last three years with the Philippine Bureau of Agriculture to encourage the increased production of binder-twine fiber in the Philippine Islands.

THE PHILIPPINE ISLANDS AS A SOURCE OF BINDER-TWINE FIBER.

With climatic and soil conditions favorable for the production of sisal, with large areas of unoccupied Government land, with a fairly abundant supply of relatively cheap labor, with good roads and cheap interisland water transportation, and with sisal plants already widely distributed in a number of different Provinces, the Philippine Islands possess the requirements essential for the development of a flourishing sisal industry.

At the time of the American occupation of the Philippines these islands were exporting each year a few hundred bales of so-called "Manila maguey" fiber. The maguey is a plant closely related to the true sisal and to Yucatan henequen, but it produces a fiber somewhat softer and finer than either sisal or henequen. It is probable that maguey (fig. 2) was originally introduced into the Philippine Islands from Mexico.

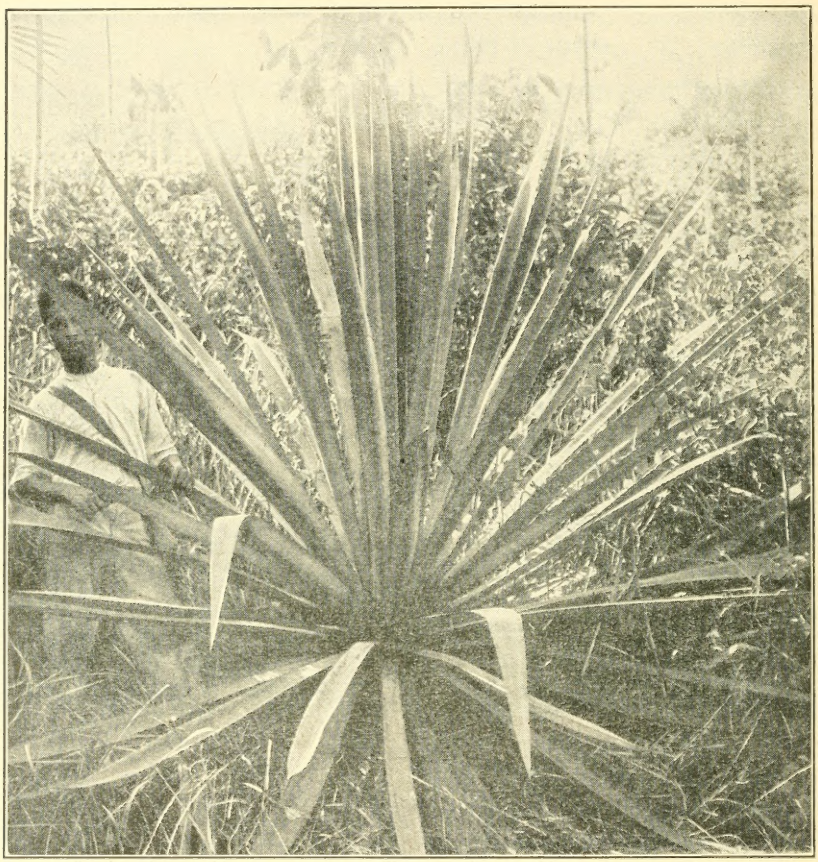

FIG. 2.—A maguey plant at the Lamao Experiment Station, Bataan Province, Philippine Islands.

In 1904 the Philippine Bureau of Agriculture organized a campaign to encourage the increased production of maguey and also imported sisal plants from the Hawaiian Islands. This work has been continued up to the present time, with the result that the exports of maguey fiber from the Philippine Islands increased from 875 tons in 1901 to 15,639 tons in 1916. The work of the Philippine Bureau of Agriculture brought about a large increase in the production of

maguey fiber in the Philippines, but it did not result in any material increase in the production of sisal fiber or in the production of machine-cleaned fiber, which is required for the manufacture of binder twine.

PRESENT CONDITION OF THE MAGUEY INDUSTRY IN THE PHILIPPINE ISLANDS.

Maguey and sisal are now grown in nearly every Province of the Philippine Islands. The production of fiber on a commercial scale is confined, however, to northwestern Luzon, where it is grown in the Provinces of Ilocos Norte, Ilocos Sur, and La Union, and to that part of the Visayan Islands which includes the islands of Cebu, Bohol, Siquijor, and a number of small islands near Cebu and Bohol. There are other islands and Provinces where conditions are favorable for the cultivation of maguey and sisal, and it is probable that, with the more general use of fiber-cleaning machines in the Philippines, there will be a gradual extension of the fiber industry into new districts.

The Ilocos Provinces of Luzon formerly produced the greater part of the maguey fiber exported from the Philippines, but there has been a rapid growth of the industry in the southern islands during recent years, with the result that this region now produces considerably more fiber than the Luzon Provinces. During the month of May, 1920, the production of maguey and sisal fibers in the Visayas was 8,801 bales, as compared with 4,482 bales produced in the Ilocano Provinces. While there is opportunity for further development of this industry in northern Luzon, the conditions are more favorable in the southern islands.

Table I shows the areas of maguey and sisal plants under cultivation in the Philippine Islands for the last eight years, as reported by the division of farm statistics of the Philippine Bureau of Agriculture.

TABLE I.—*Area devoted to the cultivation of maguey and sisal crops in the Philippine Islands for the 8-year period from 1912 to 1919, inclusive.*

Year.	Area.	Year.	Area.
	Hectares.[1]		*Hectares.*[1]
1912..	8,598	1916....	30,804
1913..	9,283	1917....	28,099
1914..	18,218	1918....	32,601
1915..	19,218	1919....	28,455

[1] A hectare is euivalent to 2.471 acres.

While these figures may represent with a reasonable degree of accuracy the areas of maguey and sisal that were actually harvested during the years mentioned, it is believed that there was an increase in 1919, rather than a decrease, in the total area planted to these crops.

During the latter part of 1917 the use of salt-water retted maguey for the manufacture of binder twine was discontinued by American manufacturers, and there has been but little demand for this product in the American markets for the last three years. As a result, the exports of maguey fiber from the Philippines during 1918 and 1919 were less than during 1916 and 1917. There has not been a corresponding decrease, however, in the area under cultivation. In a few isolated cases maguey plants have been destroyed and the fields planted to other crops, but this limited decrease in area has been more than offset by new plantings.

Table II shows the production of maguey and sisal fibers in the Philippine Islands for the last eight years, as reported by the division of farm statistics of the Philippine Bureau of Agriculture.

TABLE II.—*Total and average production of maguey and sisal fibers in the Philippine Islands for the 8-year period from 1912 to 1919, inclusive.*

Year.	Production of fiber.	Average production per hectare.	Year.	Production of fiber.	Average production per hectare.
	Metric tons.	*Piculs.*[1]		*Metric tons.*	*Piculs.*[1]
1912..	4,628	8.51	1916....	13,389	8.98
1913..	3,619	6.17	1917....	17,190	12.31
1914..	7,583	11.65	1918....	16,664	11.99
1915..	6,315	8.05	1919....	12,318	10.83

[1] A picul is equivalent to 137.5 pounds.

When the use of Philippine salt-water retted fiber for the manufacture of binder twine was discontinued in 1917 it was, for the time being, a severe blow to the maguey industry. Fortunately for the maguey planters, there was a strong demand for this fiber in countries other than the United States, which partially offset the loss of the American market. As the action taken by American manufacturers in regard to salt-water retted fiber has served to stimulate the interest of the planters in machine cleaning, this temporary loss of the American market may serve to promote, rather than to retard, the development of this industry.

There has been an increased production of maguey fiber during recent months, and the present indications are that there will be a larger output of binder-twine fiber in the Philippines in 1920 than during any previous year. Table III shows the relative production of maguey and sisal in the Philippine Islands during the first five months of 1920, as compared with the production during the same periods in 1918 and 1919.

The production of maguey in the Philippine Islands with few exceptions is a small-plantation industry. Throughout the Provinces where maguey is grown there are many small fields and even smaller patches of maguey and sisal. The owners of these small plantings

have become accustomed to methods and practices that differ materially from the methods used on the large and well-equipped sisal and henequen plantations of other countries.

TABLE III.—*Comparative production of maguey and sisal fibers in the Philippine Islands for the months of January to May, inclusive, for the years 1918, 1919, and 1920.*

Month.	Comparative production (bales).		
	1918	1919	1920
January	8,834	9,154	10,717
February	7,753	5,554	13,319
March	10,860	6,875	16,312
April	9,063	6,664	13,227
May	9,235	9,595	13,337
Total	45,745	37,842	66,912

In the planting of maguey the land, usually rough and rocky, is cleared or partially cleared of shrubs and weeds, and the maguey plants, usually small and of inferior quality, are set out more or less irregularly (fig. 3). The distance between the plants is ordinarily not more than 3 or 4 feet and frequently even less. The plantings are then entirely neglected or are kept partially cleared until such time as the maguey plants are ready for the first cutting of leaves. On account of the close planting and the lack of cultivation the maguey fields frequently become an impenetrable jungle. The first cutting of leaves is usually made before any of the leaves are mature, and at both the first and the subsequent cuttings the plants are denuded of all but a small bunch of leaves. As a result of this overcutting many immature leaves are harvested and the development of the plants is retarded.

When the prices of fiber are low the maguey plantings are neglected and occasionally destroyed. When prices are high all available leaves are harvested regardless of whether or not they are ready for cutting. Harvesting is carried on irregularly and at the convenience of the owner. After being cut from the plant, the leaves are split in narrow strips and these strips are made into small bundles. The bundles of split leaves are then taken to the nearest sea beach or to the mouth of some tidal creek and are immersed in salt water for a period of one to two weeks. When the pulpy portion of the leaves has softened and retted sufficiently the bundles are removed from the water, and, in small quantities, the retted leaves are scraped, beaten on stones, and washed in salt water until all of the pulp is removed. The cleaned fiber is then dried in the sun. With these crude and wasteful methods the Philippine Islands during the calendar year 1916 produced 125,484 bales of maguey fiber, which was approxi-

mately 7.2 per cent of the total production of Yucatan for the same year. During the first five months of the calendar year 1920 the Philippine Islands produced 66,912 bales of maguey fiber, which was approximately 20 per cent of the production of Yucatan sisal for the same period.

The production of binder-twine fiber in all countries other than the Philippine Islands is conducted as a large-plantation industry. This is primarily due to the fact that the economical production of a good quality of binder-twine fiber involves the use of expensive fiber-cleaning machinery. The economical operation of this machinery requires a large and dependable supply of leaves, such as is ordinarily

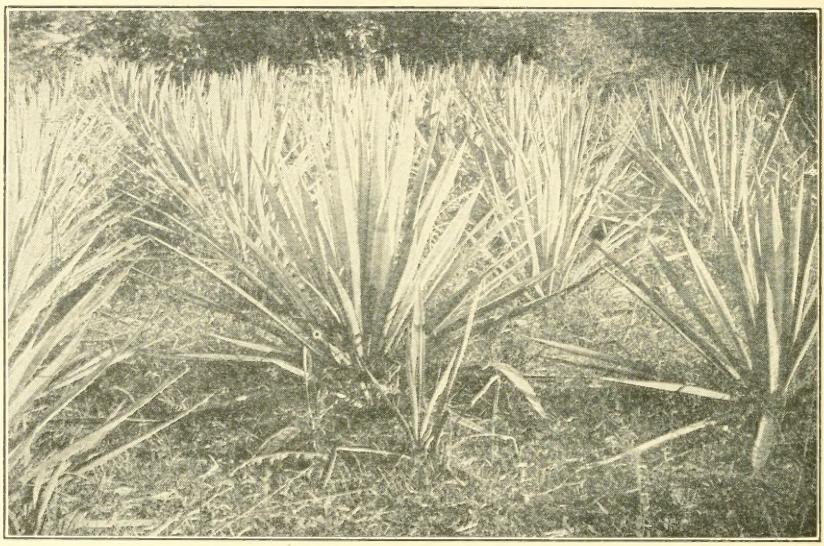

FIG. 3.—A maguey field at San Miguel, Ilocos Norte Province, Philippine Islands.

obtainable under conditions found in tropical countries only on large and well-organized plantations.

One of the fundamental problems, therefore, in encouraging the increased production of maguey and sisal fibers in the Philippine Islands is to increase the number of large plantations.

IMPROVEMENTS NEEDED IN THE MAGUEY INDUSTRY.

The reforms most urgently needed on the Philippine maguey plantations are better preparation of the land that is used for field planting, the establishment of nurseries, the use of larger and more vigorous sucker plants, wider spacing between the rows and between the plants in the row, improved cultivation, and a radical change in the methods of harvesting the leaves and cleaning the fiber.

It is possible that the introduction of cleaning machines will do more to improve conditions on the maguey plantations than any other work that can be done. The planters who are investing their capital in large modern machines will naturally be interested in their profitable operation. In order to operate them profitably a large and regular supply of good leaves is essential. The quality of leaves required for the most successful operation of the machines can not be produced without the introduction of improvements in methods of production. This fact has already been demonstrated where Government machines have been operated, and it will be more generally and more clearly understood now that machines are being purchased and operated by the planters themselves.

PURPOSE OF THE COOPERATIVE WORK WITH THE PHILIPPINE BUREAU OF AGRICULTURE.

During the calendar year 1916 it was proposed that the United States Department of Agriculture and the Philippine Bureau of Agriculture engage in cooperative work to encourage the increased production of binder-twine fiber in the Philippine Islands.

The plan of this proposed cooperation, which was subsequently approved, was based on the following essential considerations:

(1) That binder twine is now an article indispensable to practically all American grain growers.

(2) That more than 80 per cent of the binder twine now manufactured in the United States is made from henequen (Yucatan sisal).

(3) That the dependence of the American farmers and manufacturers on this one source of supply of binder-twine fiber is a serious danger to American agriculture.

(4) That it is extremely desirable that binder-twine fiber be produced in increasing quantities in territory under the control of the United States.

(5) That there are in the Philippine Islands extensive areas having conditions of climate and soil suitable for the production of maguey and sisal and these plants are already widely distributed in the Philippines.

(6) That the production of binder-twine fiber in the Philippine Islands can be increased by the use of modern methods such as have made the industry profitable elsewhere.

(7) That without the use of adequate machinery for extracting the fiber the industry can not be profitably and extensively developed.

(8) That the most important activities of this cooperative work should be the purchase, installation, and operation for demonstration purposes of fiber-cleaning machines of types regarded as best adapted to the needs and conditions in the Philippines and the distribution to the growers of approved types of plants.

(9) That the expenses, estimated at $40,000 per annum, be borne jointly by the Government of the United States and the Government of the Philippine Islands.

(10) That this cooperative work should ultimately result to the advantage of the United States by increasing the production of binder-twine fiber in the Phil-

ippine Islands to such an extent as to prevent a monopoly of this product by any one country and to the advantage of the Philippine Islands by building up an important industry in the poorest and most thickly populated Provinces.

OUTLINE OF THE COOPERATIVE WORK.

Under the terms of this cooperative agreement the Philippine Bureau of Agriculture has purchased and operated for demonstration purposes one Prieto No. 51 fiber-cleaning machine and one Prieto No. 251 fiber-cleaning machine, and has installed and operated one Prieto No. 251 fiber-cleaning machine purchased by the United States Department of Agriculture; has distributed sisal bulbils purchased by the United States Department of Agriculture in the Hawaiian Islands and sisal and maguey bulbils and suckers grown at La Carlota Experiment Station; has detailed one or more employees on extension work in the Provinces; and has conducted educational and publicity work.

The United States Department of Agriculture furnished one Prieto No. 251 fiber-cleaning machine and 500,000 sisal bulbils purchased in the Hawaiian Islands, and detailed one specialist on this work in the Philippine Islands from August, 1917, to June, 1918, and from December, 1919, to April, 1920.

When the cooperative Government work was first organized, a committee representing the United States Department of Agriculture, the Philippine Government, and the commercial fiber interests in the Philippine Islands was appointed by the Governor General of the Philippine Islands to investigate the maguey industry and to make recommendations as to the means that should be employed to encourage the increased production of binder-twine fiber in the Philippine Islands. Subsequent Government work has been based on the recommendations of this committee.

During the season of 1917–18 an educational campaign was carried on throughout the Philippine Islands for the purpose of disseminating information regarding the binder-twine fiber situation and the possibilities for increasing the production of maguey and sisal fibers in the Philippines. Field agents of the Philippine Bureau of Agriculture were detailed in the Provinces where maguey is grown to carry on extension work in the interests of the industry. Two fiber-cleaning machines were received in Manila during the latter part of 1917. These machines were first installed and tested in Manila and subsequently were installed and operated for demonstration purposes elsewhere—one in the Province of Cebu and the other in the Province of Ilocos Sur. Sisal bulbils to the number of 250,000 were imported from the Hawaiian Islands and distributed to the agricultural schools and to the maguey planters. The Government regulations providing for the classification and grading of fibers were so amended as to pro-

vide necessary grades for machine-cleaned maguey and sisal, and plans were prepared for a Government sisal plantation.

During the season of 1919–20 all of the maguey-producing Provinces were visited for the purpose of ascertaining the degree of progress that had been made and the changes or improvements that should now be made. Conferences were held with the local Government officials and the planters for a discussion of the fiber situation. All of the fiber-cleaning machines that have been installed were inspected and necessary arrangements were made for remedying any defects in the operation of these machines. Arrangements were completed for the transfer of the Government fiber-cleaning machine now located at San Fernando, Cebu, to the island of Siquijor, where the need for a demonstration of the machine is particularly urgent. Numerous tests were made with the fiber-cleaning machines that are now in operation to ascertain the capacity of these machines when operated under normal Philippine field conditions and to determine the relative results obtained with sisal and maguey fibers. Sisal bulbils were received from the Hawaiian Islands, and 250,000 distributed in the Provinces. Diseased sisal plants were located in the Province of Cebu, and arrangements were made for the destruction of these plants. A demonstration sisal nursery was planted at the Singalong Experiment Station in Manila. Plants were furnished and arrangements made for the establishment of a demonstration sisal nursery and field plantings at the College of Agriculture at Los Banos and for a course of instruction to be given at the College of Agriculture covering the more essential features of the sisal industry. A special effort was made to disseminate as widely as possible accurate information regarding the possibilities for the future development of the binder-twine fiber industry in the Philippine Islands, with a view to stimulating its continued growth.

RESULTS OF THE COOPERATIVE WORK.

THE MACHINE SITUATION.

It was considered when the cooperative work was started in 1917 that the one thing most urgently needed in order to establish the production of binder-twine fiber in the Philippine Islands on a permanently stable and profitable basis was the introduction of machine cleaning. The cleaning of maguey and sisal by retting the leaves in salt water is a slow, tedious, and wasteful process which requires much cheap labor and produces in the end a fiber of inferior quality. The retting system encourages, furthermore, the continued use of unsatisfactory methods on the plantations, as the small and immature leaves are more easily retted than the large mature leaves. With salt-water retting the only available means of cleaning maguey, the

cultivation of this crop was restricted to limited areas of land near the seacoast, as the leaves can not profitably be transported for long distances. It was clearly evident that the producers of retted maguey and sisal fibers could not hope to compete successfully with the producers of machine-cleaned sisal in other countries. If any further argument in favor of machine cleaning was necessary, it was furnished during the latter part of 1917, when American manufacturers decided to discontinue the use of salt-water retted fiber for binder twine. As the principal use of maguey had been for the manufacture of binder twine, the results of this action would have been disastrous to the maguey industry had there not been at the time an unusually strong demand for this fiber for other purposes and in countries other than the United States. There is no probability, however, that there will ever be, under normal industrial conditions, a steady demand for retted maguey and sisal fibers at prices that will make the production of these fibers a profitable industry.

In 1917 no fiber-cleaning machines for maguey and sisal were in operation in the Philippines and no commercial agencies for such machines had been established in the Islands. The planters were not familiar with the work of machines of this character and did not know where or under what conditions machines could be obtained.

One of the first lines of cooperative work undertaken was to demonstrate that maguey and sisal can be successfully and profitably cleaned in the Philippine Islands by the use of machinery. The Government has purchased, installed, and operated in the maguey-producing Provinces of the Philippines three modern fiber-cleaning machines. On account of the high cost of machinery and the lack of adequate transportation, this work has been conducted under unusually difficult conditions. It has, however, produced definite and positive results. The maguey planters have been shown that the use of machines for cleaning maguey and sisal in the Philippine Islands is entirely practicable, and a commercial agency for handling fiber-cleaning machines has been established in Manila, through which the Philippine planters are now able to purchase machines on very liberal terms.

On April 1, 1920, 18 modern fiber-cleaning machines were either in operation, were being installed, or had been ordered for use in the Philippine Islands. These 18 machines will have a total daily cleaning capacity of approximately 2,000,000 leaves. With an average yield of 50 pounds of fiber per 1,000 leaves, which is ordinarily obtained with henequen and sisal, the total daily output from 2,000,000 leaves would be 50 tons of fiber, or the total annual output, for 300 working days, would be 15,000 tons of fiber, which is more than the present total production of maguey and sisal in the Philippine Islands. With the small maguey leaves that are now obtainable in

the Philippines, from 8,000 to 10,000 leaves are required to produce 1 picul (137.5 pounds) of fiber. Two million leaves of this character would produce 15 tons of fiber, or with a daily supply of 2,000,000 leaves an annual output of 4,500 tons of fiber. The machine situation in the Philippine Islands may be summarized by the statement that a sufficient number of modern fiber-cleaning machines to clean from one-third to one-half of the present total output of maguey and sisal fiber have already been installed or have been ordered by the planters. It is not unreasonable to assume that this situation is largely the direct result of the cooperative work organized and carried on by the Government.

An important problem in connection with the machine work has been that of determining the type of machine best adapted to existing Philippine conditions.

With respect to size and cleaning capacity, three standard types of fiber-cleaning machines are now manufactured in the United States. These types are represented by the small machine, which cleans 3,000 leaves per hour; the medium-sized machine, which cleans 5,000 leaves per hour; and the large machine, which cleans 15,000 leaves per hour. The manufacturers ordinarily recommend the purchase of the larger machines, as it is claimed that they are more easily, satisfactorily, and economically operated.

The Philippine planters, before the Government demonstrations with machines were made, were urgent in their demand for small machines. The arguments presented in favor of the small machines were that practically all the maguey plantations were too small to furnish the number of leaves required for the operation of a large machine and that but few of the planters had sufficient capital to purchase such a machine.

When the three Government machines were obtained it was considered advisable to purchase one machine of the smallest size and two of medium size. It was desired to ascertain whether the small machines could be profitably operated under Philippine conditions, and it was believed that the largest machines would be found too large to meet the requirements of the Philippine planters. These three machines have been operated intermittently for a period of two years with the following results:

With the small maguey leaves, which constitute practically the entire leaf supply now available in the more important fiber-producing Provinces, the capacity of the small machine is not sufficient to make its operation profitable. With sisal or with large maguey leaves it appears that this size can be operated with a small margin of profit.

The factor of small leaves and consequent lessened cleaning capacity is not as serious a matter with the medium-sized machine as it with the small one. With good business management and an adequate supply of leaves it should be possible to operate this machine profitably under existing Philippine conditions.

Although the large machines have not yet been tested in the Philippines, the indications are that in locations where a large supply of leaves is obtainable these will prove to be most satisfactory.

Having observed the Government demonstrations that have been made with machines, most of the Philippine planters now prefer the largest machines that can be obtained. This is shown by the fact that during the last year orders have been placed for 11 of the large machines and 1 of medium size. None of the small machines have been purchased during this period.

A number of tests have been made with the Government machines for the purpose of determining their capacity, the yield of fiber obtained from a given number of leaves, the relative yields of maguey and sisal, the relative quality of fiber obtained from maguey and sisal, and the relative percentage of fiber obtained by machine cleaning and retting. As these machines were adjusted for cleaning maguey rather than sisal, as the men who operated the machines were not accustomed to handling the large sisal leaves, and as sisal leaves of satisfactory quality were not obtainable, the results of these tests so far as sisal is concerned can not be considered as conclusive.

It was found that the medium-sized machine, the cleaning capacity of which was supposed to be 5,000 leaves per hour, will, under average conditions, clean about 7,000 of the small maguey leaves per hour. In one test made with 1,000 leaves, cleaning was done at the rate of 10,909 leaves per hour. The best result obtained with sisal was 4,615 leaves per hour.

The yield of fiber obtained from the average-sized maguey leaves was about 17 pounds per 1,000 leaves, or approximately one-third of that ordinarily obtained from henequen and sisal. The largest yield from maguey in any of the tests was 26 pounds of fiber per 1,000 leaves. While these leaves were considerably larger than the average of the maguey leaves that are now being cleaned, they were much smaller than the maguey leaves that can be produced on plants which are properly planted and cared for. The largest yield of sisal obtained in these tests was 47.74 pounds of fiber per 1,000 leaves, while other tests gave considerably smaller yields. As it was impracticable to obtain sisal leaves of satisfactory size and quality, these tests should not be considered as an indication that Philippine sisal produces less fiber than the sisal of other countries.

With the quality of maguey leaves now obtainable and with favorable operating conditions, the medium-sized machine should clean approximately 1,500 pounds of maguey fiber in an 8-hour day. In all the tests the weight of sisal fiber cleaned in a given period of time was less than that of maguey fiber cleaned in the same period.

Two tests indicate that the machines clean sisal more satisfactorily than maguey. The results obtained in these tests were as follows:

Maguey.—10 per cent grade A, 75 per cent grade B, 15 per cent grade C.
Sisal.—85 per cent grade A, 15 per cent grade B.

The tests made to determine the relative percentage of fiber obtained by machine cleaning and retting indicated that with both maguey and sisal the retting process gives a slightly larger percentage of fiber than is obtained with machine cleaning.

The essential conclusion that can be drawn from the results of these tests is that, with good business management and an adequate supply of leaves, the medium-sized and probably the large fiber-cleaning machines can be profitably operated in the Philippine Islands and can be used for cleaning either maguey or sisal.

THE SISAL SITUATION.

A detailed and accurate statement showing the relative value of sisal and maguey when grown under Philippine conditions can not be made at the present time. It would not be possible to find in any one locality in the Philippine Islands even 1 acre each of properly cultivated maguey and sisal from which complete and reliable data could be obtained. No accurate data are obtainable showing the production of leaves and fiber for a given area of either sisal or maguey in the Philippine Islands. It appears, however, that sisal will prove to be a more profitable crop than maguey in the Philippines. This assumption is based on the known production of sisal in other countries and the estimated production of maguey in the Philippines, as well as on the fact that sisal leaves are more easily and satisfactorily cleaned by the machines than maguey leaves and that sisal fiber is more satisfactory than maguey fiber for binder-twine purposes. (Fig. 4.)

During the last year it has been ascertained that maguey leaves can be satisfactorily cleaned by the machines without being crushed before cleaning, and the tests indicate that a given weight of maguey leaves will produce a larger percentage of dry fiber than the same weight of sisal leaves. These facts, while having an important bearing on the subject of the relative value of sisal and maguey, may be taken to indicate that maguey can be profitably grown where sisal is not readily obtainable, rather than the conclusion that maguey is a more profitable crop than sisal.

For a number of years the Philippine Bureau of Agriculture has been importing sisal plants from the Hawaiian Islands, and during the last two years the United States Department of Agriculture has purchased 500,000 sisal bulbils for distribution in the Philippines.

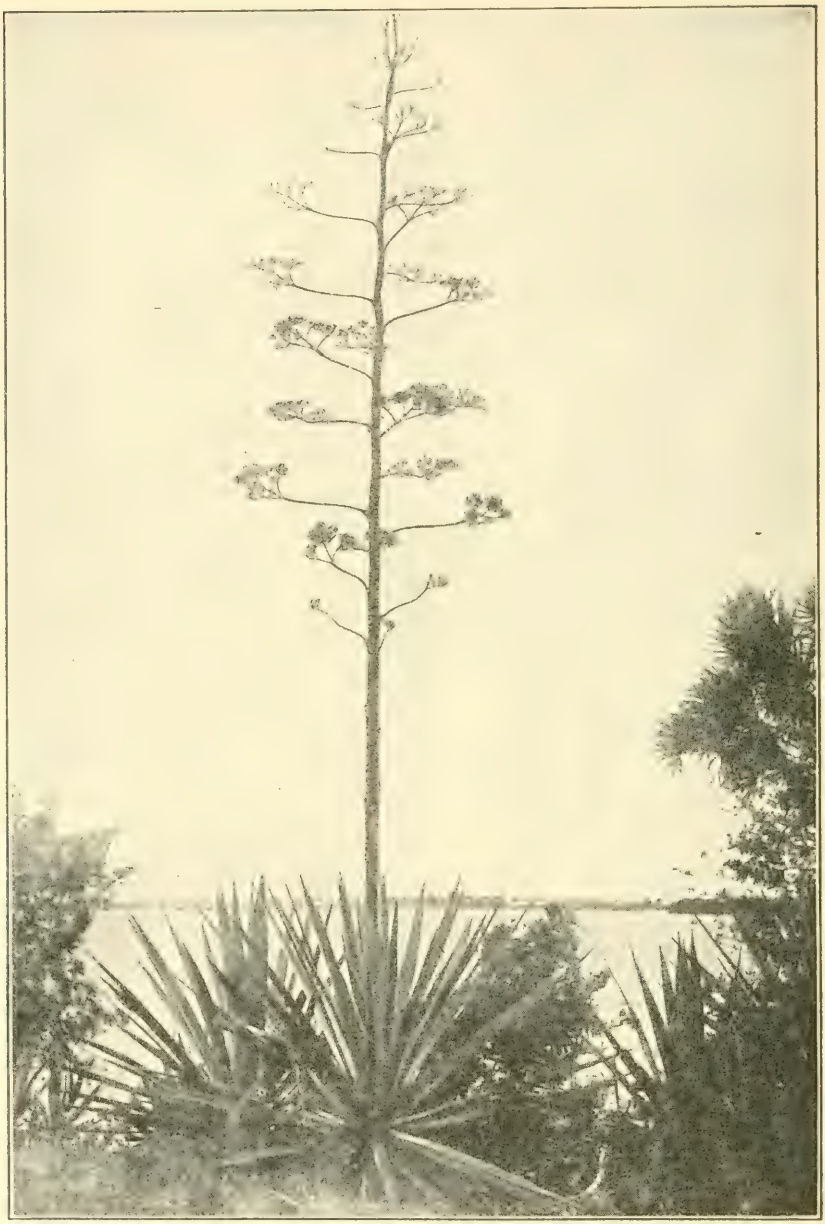

FIG. 4.—Sisal in Florida. The more important sisal plantings throughout the world have originated from plants grown in Florida, although that State has never produced sisal fiber in commercial quantities.

The shipment of 250,000 sisal bulbils received in Manila in 1918 was distributed by the Philippine Bureau of Agriculture to planters and to agricultural schools in the Provinces. Arrangements had been made for placing these plants in Government nurseries, but lack of

funds made it impossible to establish them. It was believed that it would be advisable to have a number of small demonstration plantings in connection with the school gardens at various places in the maguey-producing Provinces. The results obtained with the school-garden nurseries were not satisfactory, and future distributions will be made direct to the planters.

In March, 1920, a second shipment of 250,000 sisal bulbils was received in Manila. As fiber-cleaning machines are now being installed at different places both in the Ilocos Provinces and in Cebu, and as the machines do more satisfactory work with sisal than with maguey, it was considered advisable to limit the distribution of these plants to a small number of responsible planters whose plantations are located near the places where machines are to be installed. Some of these plants were used for demonstration nurseries at the Singalong Experiment Station in Manila and at the College of Agriculture in Los Banos.

While the establishment of sisal in the Philippines has been slow, the distribution of Hawaiian plants has been by no means without results of value. From the Government nurseries at La Carlota, in the Province of Occidental Negros, large numbers of sisal bulbils and suckers have been distributed. A sisal industry has been established on the island of Siquijor, which is now the principal industry of that island, and it is probable that the Siquijor industry alone would justify all expenditures that have been made by the Government in this work.

The introduction of cleaning machines in the Philippines will probably result in a decided change in the attitude of the planters toward sisal, and in the localities where machines are installed it should be possible to get sisal nurseries established. Wherever a machine has been operated the planters have had an opportunity to see that sisal is cleaned more easily and produces a better quality of fiber than maguey.

The principal source of supply of sisal plants in the Philippine Islands is the island of Siquijor. While the Siquijor plantings are quite widely scattered and accurate data showing the total area are not available, there are several hundred acres of sisal on that island. On Cebu there is a sisal plantation in the municipality of Borbon, in the northern part of the island. In 1916 the Philippine Bureau of Agriculture obtained 100,000 sisal bulbils from this plantation, and both suckers and bulbils are available at Borbon at the present time. There are a number of smaller plantings in different parts of Cebu, and throughout all of the maguey-producing Provinces there are small patches and scattering plants of sisal.

Unless the demand for sisal plants in the Philippine Islands becomes much greater than now appears probable, the plantations of Siquijor,

Cebu, and Bohol should furnish an abundant supply of suckers and bulbils for future use.

IMPROVEMENTS ON PLANTATIONS.

The field agents of the demonstration and extension division of the Philippine Bureau of Agriculture have been working with the maguey planters for a number of years with a view to encouraging the use of improved methods on the plantations. It has been extremely difficult to get satisfactory results in this work, as most of the producers of maguey have small plantings only and are not disposed to make any changes in the methods to which they are accustomed. With the introduction of cleaning machines and with the consequent increased demand for maguey and sisal leaves of good quality, there will be an opportunity for the employees of the Philippine Bureau of Agriculture to continue this work under much more favorable conditions than those which have existed in the past.

SUMMARY.

Important agricultural and manufacturing industries of the United States are now largely dependent on supplies of imported raw products. Necessary action should be taken to safeguard our future supply of these products.

The grain-producing industry of the United States can not be maintained without the use of harvesting machinery, and this machinery can not be operated without binder twine.

The greater portion of the binder twine used in the United States is manufactured from henequen and sisal fibers, and more than 90 per cent of the total supply of these fibers imported into the United States is received from Yucatan.

This dependence of our most important agricultural industry on one small State of a foreign country constitutes a grave menace to American agriculture.

In order to remedy this situation, it is essential that an increased supply of binder-twine fiber be produced within the territory of the United States or in countries over which the United States exercises political control.

The Philippine Islands possess the requirements necessary for the development of a flourishing sisal industry.

The production of binder-twine fiber in the Philippine Islands has been restricted in the past by reason of the antiquated methods that are in general use by the planters, and a number of reforms in this industry are urgently needed.

For the last three years the United States Department of Agriculture has been cooperating with the Philippine Bureau of Agriculture

for the purpose of encouraging the increased production of binder-twine fiber in the Philippine Islands.

The more important lines of work undertaken have been the introduction of machine cleaning to replace the unsatisfactory retting process, the distribution of sisal plants, and the introduction of improvements on the plantations.

As a result of this work, machine cleaning has been established on a commercial basis, and 12 large modern fiber-cleaning machines have been purchased by Philippine planters during the last 18 months; 500,000 sisal bulbils have been imported into the Philippine Islands from the Hawaiian Islands; and there is now enough sisal in the Philippines to furnish an abundant supply of plants for future use. While there has been no marked and widespread improvement of conditions on the plantations, there has been a fair degree of progress.

The production of maguey and sisal fibers in the Philippine Islands for the first five months of 1920 has been larger than during any similar period in previous years. During this period the production of Philippine maguey and sisal has been approximately 20 per cent of the henequen production of Yucatan.

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